# STONES IN THE COMMON DUCT AND THEIR SURGICAL TREATMENT,

## WITH REMARKS ON THE BALL-VALVE ACTION OF FLOATING CHOLEDOCHUS-STONES.

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(Continued from page 156.)

Anatomy. In attempting to outline the field of operation for the common duct, and its topographical anatomy, it must be remembered that when operating we do not have a normal duct to deal with, but a duct more or less dilated. I, therefore, think it justifiable to use the specimen here presented as a paradigm, and the exact anatomical relations between the organs in the hilus of the liver in this specimen will hold good for the majority of the cases of this kind with which we have to deal. I have found this to be the case in four out of five cases in which I have operated, and think it safe to conclude that the conditions about to be described will be those generally found. I will describe the organs in the position in which the operations are made; the patient lying on the table in the dorsal position and the anterior border of the liver held up by assistants, which makes its normally somewhat dependent position almost vertical; that is, the plane of the lower surface of the liver forms a right angle with the frontal plane of the body. Thus, the vertical position is changed, when the patient is upright, to a horizontal position. This does not change the relations of right to left, but changes the anterior or horizontal direction to a vertical or upright one, and *vice versa*. The vessels, bile-passages, and duodenum have been injected with colored paraffin. (See colored plates I and II.)

The organs to be considered are located between the two folds of the hepatico-duodenal ligament. This extends from the transverse sulcus, called the hilus of the liver, downward and consequently backward to the transverse colon, the duodenum, and the lesser curvature of the stomach, from right to left. Its right border is free and forms a free border between the posterior and anterior surface, being the free border of the entrance to the cavity of the lesser omentum, the anterior border of the so-called foramen of Winslow. The posterior surface is the anterior wall of the beginning of the lesser omental sac, and a finger introduced at this point will have the bile-ducts, vena porta, and hepatic artery on its anterior surface. The anterior surface of the ligament is covered with peritoneum from the large peritoneal cavity, continuous with the anterior surface of the greater omentum. When the index and third fingers of the left hand are passed into the foramen of Winslow and the thumb laid on the anterior surface of the ligament, the organs in question will be between the ends of the fingers. The ligament is on the average 5 to 6 cm. long, 3 to 4 cm. broad; its direction, being the direction of the common duct, is oblique, and forms an angle of about 54° with the frontal plane of the body.

*Lymph-glands.* In the loose connective tissue below the anterior (lower) surface of the ligament are situated from two to four lymph-glands, usually somewhat enlarged; I have seen them as large as a walnut. The upper, anterior glands are situated on the vena porta; the lower, posterior ones on the anterior surface of the common duct. In the connective tissue in this locality and running in the direction of the common duct there are three or more branches of the vena porta 1 to 2 mm. in diameter, 3 to 4 cm. long, and two or three branches of the hepatic artery of the same length and about 1 mm. in diameter.

*Common Duct.* The common duct is 6 to 7 cm. long, runs in an oblique direction, forming an angle of 45° with the frontal plane of the body, and when it contains a stone or stones is ordinarily dilated. It is thus 15 to 20 mm. in diameter, and may be divided into three portions, each 2 to 2½ cm. long. .

The upper or anterior portion, nearest the hilus, begins at the junction of the cystic and hepatic ducts. Its upper half is partially covered with the main trunk of the vena porta, which gradually retreats from its anterior to its posterior surface, to disappear behind the common duct at about its middle.

The middle portion has no vena porta on its anterior surface, but the upper half of the lower or right border is overlapped by the retreating vena porta. At its upper or left border the hepatic artery passes behind it on its way to the hilus of the liver, and at this point gives off a branch which passes forward on the anterior surface of the common duct, where it divides into two branches, one of which runs upward and to the right to the cystic duct, the other downward and to the left on the anterior surface of the lower half of the common duct. This middle portion of the common duct, the anterior surface of which is not in relation with the vena porta, is the place of choice for the incision in choledocholithotomy, as at this point only small branches of the vena porta and hepatic artery, as already described, are met with—vessels too small to cause serious or uncontrollable hemorrhage. Its upper border, together with the right free border of the duodenum and the hepatic artery, forms a triangular space.

The third, lower or posterior portion of the duct is almost entirely hidden by the duodenum which covers its anterior surface and its entire upper border for 2 to 2½ cm., while only 1 to 1½ cm. of its lower border is covered by the intestine. This part of the duct lies partly in the head of the pancreas. Its lower end is, as a rule, dilated and forms a cul-de-sac, usually a little smaller than the duct higher up, and at some place in this cul-de-sac (the dilated diverticulum Vateri) the opening into the duodenum is situated. The possibility of passing a sound down into the intestine from the incised common duct depends upon the situation of the duodenal opening in this cul-de-sac, and upon the direction of the canal through the wall of the duodenum. In some cases it is easy to pass a sound down, in others impossible, although the opening may allow free exit to bile (this may be due to valve-formation or to the fact that the probe or bougie is caught in a fold). The head of the pancreas overlaps or comes down below the lower border of this portion of the duct for 1 cm. or more.

*Vena Porta.* The vena porta commences behind the pancreas, runs as a trunk 18 mm. in diameter from left to right, slightly upward, first, behind the middle portion of the common duct; about its middle it emerges on the lower or right border of the duct and runs from here upward and to the right for a distance of 3 to 3½ cm., when it divides into its hepatic branches. On its way it passes from the posterior surface around the lower border up on to the anterior surface of the upper portion of the duct and covers the lower part of this, extending to or a little upon the cystic duct. The terminal portion of the vena porta is situated on the anterior surface of, and consequently covers, the hepatic duct and its branches. Its termination is about 10 cm. above and to the right of the end of the cystic duct; in dividing, it gives off a main branch for the right lobe of the liver at an angle of about 110°, which passes downward and to the right. This main branch is 1½ cm. long and 10 to 12 mm. in diameter. From the place of division a branch for the quadrate lobe, 2 cm. long and 7 mm. in diameter, passes downward, backward, and a little to the left. At the left border and behind this branch is the bile duct for this territory of the liver, which is 3 mm. in diameter. Behind the bend and the upper border of the branch to the right lobe the upper border of the right branch of the hepatic duct comes into view. At the place where the trunk of the vena porta curves around from the lower upon the anterior surface of the common duct it takes up three other branches which run along this surface.

*Hepatic Artery.* From behind the pancreas, the hepatic artery, with a trunk 3 mm. in diameter, passes from left to right into the hepatico-duodenal ligament, for a distance of 15 mm. from the right border of the duodenum horizontally to the right until it reaches the common duct; then on its posterior surface into the hilus of the liver. When it reaches the common duct it gives off a branch which passes forward to the anterior surface of the common duct. This branch soon divides into two or three smaller branches, one running upward and to the right for the upper part of the common duct and the cystic duct, the others downward and to the left to supply the middle and lower portions of the common duct.

*Cystic Duct.* The cystic duct is about 4 cm. long; its lower half, which runs upward and to the right in the direction of the common duct, is 10 mm. in diameter, but gradually diminishes until its diameter is only 4 mm. Its upper portion runs vertically, forming an obtuse angle with the lower portion, the concavity being to the left. At its entrance into the gall-bladder in this specimen it is only 3 mm. in diameter. (In the specimen here described a round diverticulum, thin-walled, 2 cm. in diameter, was found upon its upper vertical portion.) The upper or distal half of the cystic duct may be incised in a vertical direction for the removal of stone at any place in its extent without wounding the vena porta; the lower or proximal half should be incised for stone as far from its lower or right border as possible so as to avoid wounding the vena porta.

*Hepatic Duct and its Branches.* The hepatic duct goes off from the common duct at the same place as the cystic duct and bends backward behind the latter and behind the vena porta and its branches. It is 2½ to 3 centimetres long, passes to the right, downward and backward, and then divides into the branches for the liver. The upper border of the upper anterior branch to the right lobe can be seen behind and over the border of the vena porta. The branch to the quadrate lobe can be seen to the left behind the corresponding branch of the vena porta. The hepatic duct is thus situated behind and is covered by the cystic duct and the vena porta. A stone in this duct can therefore scarcely be felt from the anterior surface through these two organs, and when a floating stone is pushed or passes up here it apparently disappears into the liver, and search and manipulation are required to bring it again down into the common duct.

*Gall-bladder.* The gall-bladder, when distended, is pear-shaped, with its fundus toward the free border of the liver which, in its normal condition, it never overlaps, so that it can never be felt when the condition of the patient is normal (Rheinstein). It is from 8 to 14 cm. long and 3 cm. in diameter. At the entrance to the cystic duct it narrows down to 3 mm. in diameter. When retracted and atrophic from inflammation or protracted emptiness and disuse, as in the specimen here described, it may shrink to a length of 4 cm. and to a diameter of 1½ cm., or, as in Case V., to even smaller dimensions.

REMARKS.. The descriptive anatomy as detailed in the text- and handbooks differs to a great extent from that just given, partly because of the pathological condition of the specimen described—the dilatation of the common and hepatic ducts and the atrophy of the gall-bladder; but at the same time the position of the vena porta in its relation to the bile-ducts is so different from that given by Henle that I hardly think that the entire difference can be due to the pathological condition. Henle says (page 200): "The common duct is situated at the right free border of the hepatico-duodenal ligament or at the free border which forms the fold at the entrance of the foramen of Winslow. The hepatic artery is situated on its left side close to it, and behind both lies the vena porta."

These are entirely different relations between the upper part of the common duct, and particularly the hepatic duct, from those found by me, and would naturally lead to the conclusion that any of these ducts might be incised without risk of opening into the vena porta. From the relations described by me it will be seen that a stone in the hepatic duct cannot be cut down upon without passing through the vena porta, with the exception, perhaps, of a small place at the beginning of the duct and behind the cystic duct. In the upper half of the common duct it is unsafe to incise close to the free border of the hepatico-duodenal ligament, because the vena porta here may overlap the right or lower border of the common duct; and it is only the lower half of the common duct that lies close to the free border of the ligament, entirely covering the vena porta. Thus only the lower or right half of the common duct can be incised without danger of opening into the vena porta.

PATHOLOGY. It has been the general belief that most of the choledochus-stones are formed in the gall-bladder and pass secondarily through the cystic duct down into the common duct. We also know that stones form in the hepatic branches and consequently, in all probability, also in the hepatic and common ducts. In 62 out of 150 cases, one or more stones were found in the common duct alone. In the remaining 88 cases stones were found simultaneously in one or more of the biliary passages. (Courvoisier.)

The stones in the common duct are ordinarily from 1 to 2 cm. in diameter; that is, they are on the average larger than the stones in the gall-bladder. In two-thirds of the cases only one stone has been found; in the remainder from two to six, but seldom in large number. The shape is usually oval, more rarely globular or irregular.

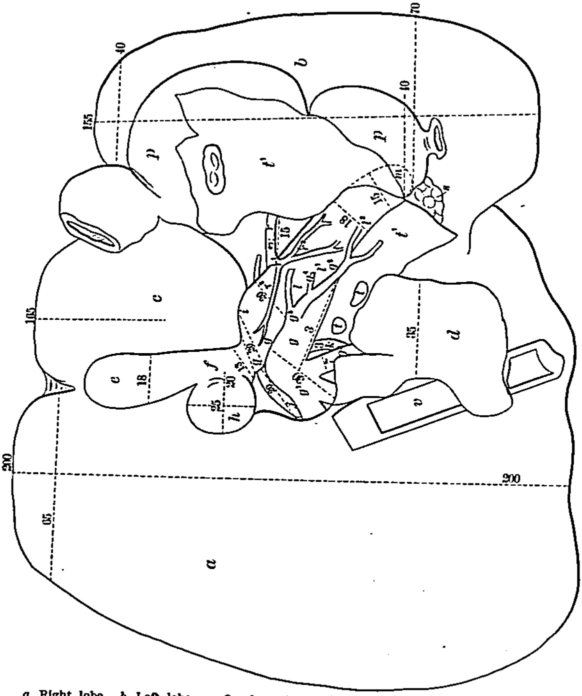
The locality in the common duct where the stones are found (according to Courvoisier) is, in 67 per cent. of the cases, the lower or duodenal portion, in about 15 per cent. in the upper or hepatic portion, and in the remaining 18 per cent. in the middle portion. I think it is singular that Courvoisier devotes so little attention to floating stones. He says: "The stone was sometimes—in 5 cases only out of 150—found movable in both directions in its cul-de-sac," but does not seem to appreciate that a stone might float through the entire common duct. As he makes his deductions from the literature, it is likely that other authors have overlooked the mobility of the stones in many cases and have simply noted the place where the stone was found, paying no attention whatever to the ease with which it could be moved; for instance, from the more narrow duodenal portion up into the wider upper territory of the common duct.

The natural and usual effect of a stone in the common duct is occlusion to the passage of bile and subsequent dilatation of the biliary passages in a proximal direction. Dilatation of the common duct was noted in 47 out of 200 cases. The duct was dilated from the size of the thumb up to 2 to 4 cm. in diameter. It was rarely—in 14 cases only—dilated to a large cyst-like cavity. The hepatic duct and its intrahepatic branches were found dilated in 25 per cent. of the cases. While it was always believed previously that the gall-bladder would be found dilated in cases of obstruction from choledochus-stones, Courvoisier found, in 1890, to his great surprise, that the gall-bladder was atrophic and more or less empty in 80 per cent. of the cases of choledochus-stone and dilated in only 20 per cent. He explains this curious fact in the following manner: Supposing the stones are found in the gall-bladder and have secondarily emigrated to the common duct, they have caused while in the gall-bladder a chronic inflammation of its walls, terminating in retraction and atrophy. In support of this view, he mentions cases in which local losses of substance or cicatricial territories indicated pre-existing gall-stones. But in many cases such traces of local injury are not found; the cystic duct is open and normal. The atrophy in these cases, hitherto incomprehensible, is easily explained by the ball-valve action of a floating choledochus-stone at the distal end of the cystic duct, as described above. This atrophy of the gall-bladder is, as Courvoisier has rightly pointed out, so characteristic for choledochus-stone that it is a valuable symptom in the differential diagnosis between stone and other causes of occlusion of the common duct.

Out of 35 operations for obstruction of the common duct, collected by Courvoisier, 17 were on account of stone and 18 on account of non-calculous obstructions, strictures, tumors, obstructions within or outside of the duct, etc. In 4 of the 17 cases of stone the gall-bladder was dilated; in 13 it was atrophic. In the 18 cases of non-calculous obstruction the gall-bladder was dilated in 16, and in only 2 was there no ectasia.

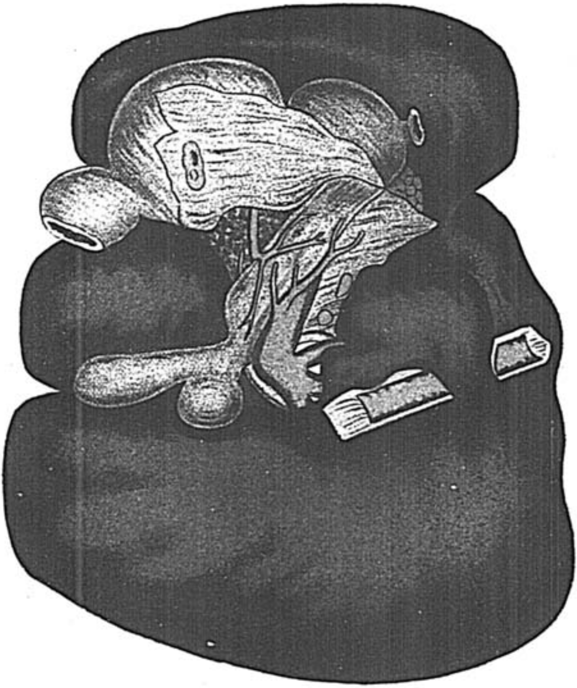
The contents of the dilated biliary passages is ordinarily bile, either normal, light yellow, or thickened and dark. Pus was found in only a minority of the cases; empyema of the gall-bladder in 8 cases; empyema of the bile-ducts—that is, suppurative cholangitis—in 5 cases; and these conditions combined, in 5 out of a total of 18 cases. In 10 cases only, the dilated biliary passages contained no bile, but either watery, colorless, or slightly mucoid fluid bearing no resemblance to bile, a condition of acholia ascribed to pressure-atrophy of the liver-cells, depriving them of the faculty of manufacturing bile. In all the 10 cases collected by Courvoisier, not one case of gall-stone was found,

## KEY TO PLATE I.

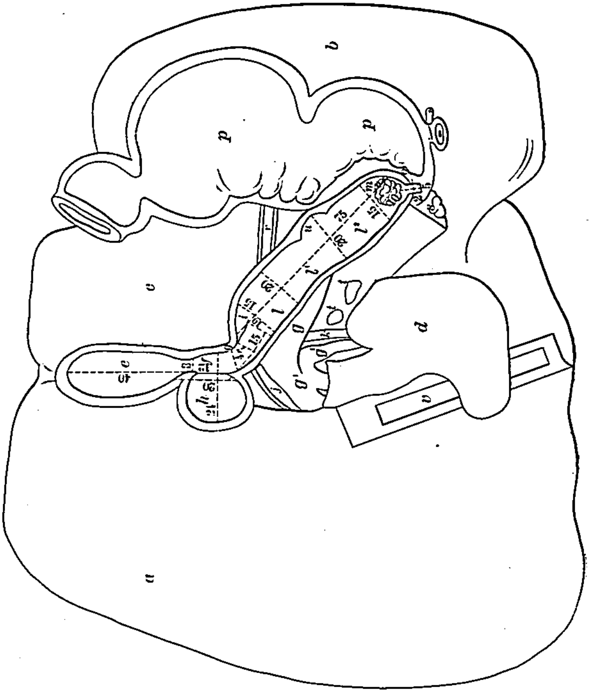


*a*. Right lobe. *b*. Left lobe. *c*. Quadrate lobe. *d*. Lobus Spigelii. *e*. Gall-bladder. *f*. Upper vertical portion of cystic duct. *g*. Lower oblique portion of cystic duct. *h*. Diverticulum in upper portion of cystic duct. *i*. Hepatic duct. *j*. Branch of hepatic duct to right lobe. *k*. Branch of hepatic duct to lobus Spigelii. *l*. Common duct, upper portion. $l^1$. Common duct, medial portion. $l^2$. Common duct, lower portion. *m*. Diverticulum of Vater. *p*. Duodenum. *q*. Vena porta. $q^1$. Vena porta branch to right lobe. $q^2$. Vena porta branch to lobus Spigelii. $q^3$. Vena porta branch taking up—$q^4$. $q^5$. Smaller branches of vena porta from anterior surface of common duct located in hepatico-duodenal ligament below its anterior peritoneal surface. *r*. Trunk of hepatic artery. $r^1$. Branch of hepatic artery to anterior surface of common duct giving off—$r^2$. Branch of hepatic and cystic ducts, and $r^3$. Branch of lower half of common duct. *s*. Pancreas. *t*. Lymph-glands in hepatico-duodenal ligament. $t^1$. Peritoneal surface of hepatico-duodenal ligament divided and dissected off from vena porta and common duct. *v*. Vena cava inferior.

# PLATE I.



## KEY TO PLATE II.



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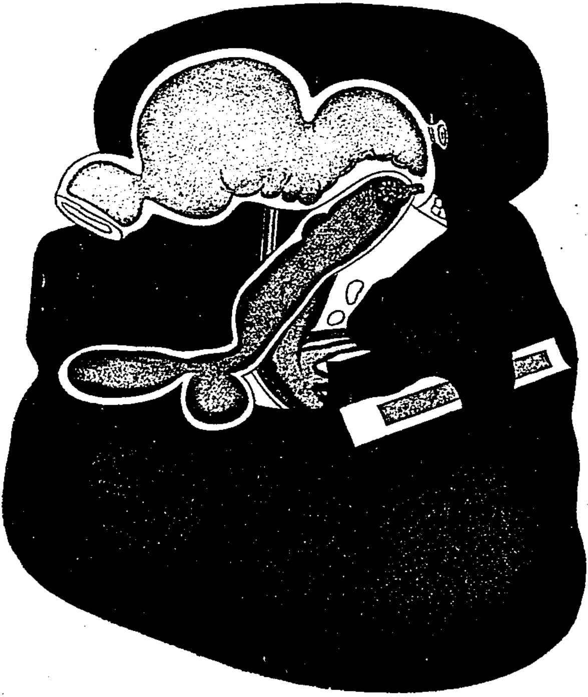
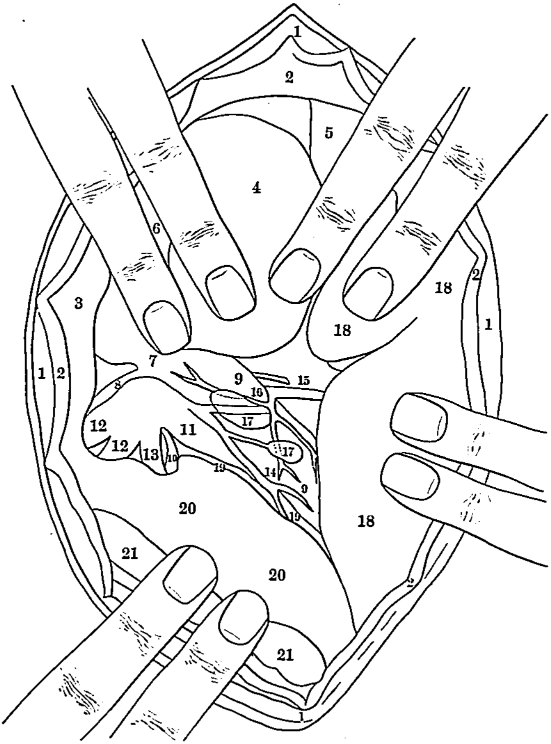
# PLATE II.



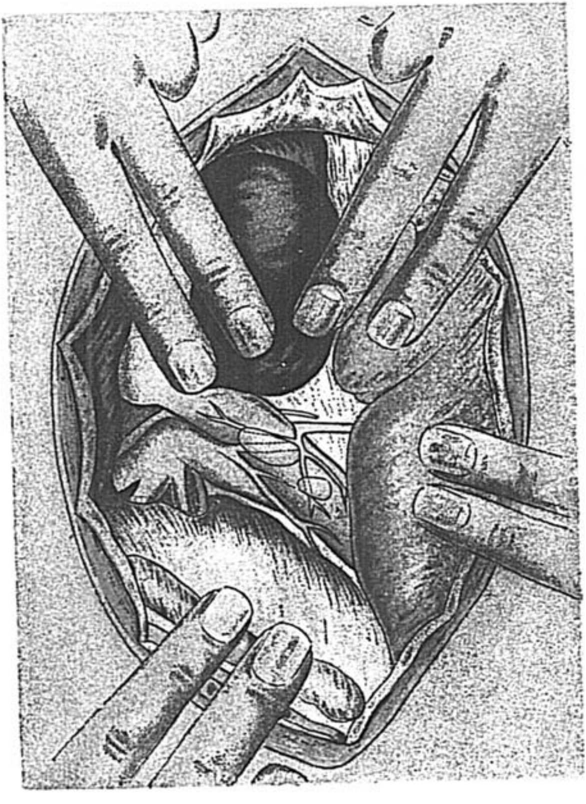
## KEY TO PLATE III.



FIELD OF OPERATION.

1. Wound through abdominal wall. 2. Parietal peritoneum sutured to skin. 3. Right lobe of liver, lower surface. 4. Quadrate lobe of liver. 5. Suspensory ligament of liver. 6. Gall-bladder. 7. Cystic duct. 8. Hepatic duct. 9. Common duct. 10. Branch of hepatic duct to lobus Spigelii. 11. Trunk of vena porta. 12. Branches of vena porta to right lobe. 13. Branches of vena porta to lobus Spigelii. 14. Small branch of vena porta in hepatico-duodenal ligament. 15. Hepatic artery. 16. Branches of hepatic artery to hepatico-duodenal ligament. 17. Lymph-glands in hepatico-duodenal ligament. 18. Duodenum. 19. Entrance to foramen of Winslow. 20. Hepatico-colic ligament. 21. Transverse colon.

PLATE III.



be seen that colic speaks strongly for choledochus-stone as the cause of occlusion, as opposed to tumors.

Preceding attacks of colic indicate choledochus-stone which has passed into the duodenum. Courvoisier states that in fifty-one cases of choledochus-stone colic stones were found in the feces in only five cases.

Colic is a natural companion to icterus of sudden onset, but continued attacks of colic and icterus speak for occlusion from stone in the common duct, either temporary, when the stone passes down into the duodenum, which is relatively rare; remittent, in floating choledochus-stones, which is common; or, finally, permanent, when the stone is impacted and causes complete, permanent occlusion, which is also rare.

4. *Localization of Pain.* In the cases of stone in the common duct the pain, according to my observation, is seldom localized in the region of the gall-bladder or in the right hypochondrium, unless concomitant inflammation of the gall-bladder, caused by stones in that viscus, is present. I found the pain located in the epigastrium in Cases II., III., and V.; in III. and V. there was simultaneous pain in the region of the gall-bladder. The pain was located in both lumbar regions in Case VI.; equally in both hypochondriac regions in Cases V. and VI.; and in the lower part of the back or lower dorsal region in Cases I., II., III., and VI. I consider this localization of pain outside of the gall-bladder as a characteristic symptom of floating choledochus-stone.

5. *Remittent Pain.* The frequent remittence of pain, either slow or sudden in onset, and suddenly disappearing, attended by a flow of bile, but with no stone in the feces, signifies a single stone or a few stones that do not pass through, but float in a dilated common duct. The attacks of colic or pain in the course of the disease become more and more frequent, from once or twice a month to once or twice a week, and in some cases even daily. In Case II. the attack of pain lasted for ten hours; in Case V. from half an hour to two hours.

6. *Vomiting.* Vomiting was present in Cases I., II., III., and V. In Case VI. the patient experienced relief from vomiting, so much so that she was accustomed to force vomiting in order to gain relief from the pain.

7. *Relief of Pain in Certain Positions.* The pain is frequently relieved and the attack brought to an end by changes of position, which probably displace the floating stone, or by the maintenance of some one position. In Case IV. the patient obtained relief by lying on the stomach; in Case VI. by inducing vomiting; in Case V. by flexing the thighs upon the abdomen.

8. *Loss of Weight.* An important and characteristic symptom I have found to be the rapid and considerable loss of weight, which cannot be explained by fever, as fever is either absent or only of slight degree; by sepsis in the bile, as the bile may be aseptic, as in Case IV.; or by the

severity of the icterus, as icterus is frequently slight, and as the feces are intermittently or generally bile-colored. The loss of weight must, in my opinion, be attributed to intermittent, frequent ptomaïne-intoxication—that is, bile-absorption, as well as to disturbed digestion.

The loss of weight is characteristic and rapid, and after the operation the patient rapidly regains weight. In Case I. the loss of weight was sixty pounds; in Case II. the patient lost fifteen pounds in ten weeks, but after the operation gained fifty pounds in three months; in Case III. the patient lost fifty pounds, and after the operation gained twenty pounds in three months; in Case IV. the patient lost twenty-five pounds in seventeen days, and after the operation gained forty pounds in forty days; in Case V. the patient lost twenty-three pounds; and in Case VI. the patient lost fifty-three pounds, and since the operation has gained thirty-eight pounds in weight. In Czerny's Case XX., reported by Mermann, the patient lost thirty-six pounds, and after the operation gained forty pounds in nine months; in Case XXI. the patient gained four pounds in one month after the operation; and in Case XXII. there was a loss of weight of twenty-five pounds.

9. *Fever.* Intermittent or remittent biliary fever ordinarily follows or precedes the attacks of colic and icterus. It is not yet decided whether this rise in temperature is due to absorption of retained aseptic bile, or whether the microbic invasion from the intestine, which infects the bile, causes inflammation of the wall of the duct, thus making the fever septic. Charcot described an intermittent hepatic fever due to absorption of retained aseptic bile. Schüppel is inclined to believe that inflammation—that is, infection from microbes—is essential in the causation of fever. Courvoisier, after analyzing the cases collected from the literature, found fever in 25 per cent. of the cases of occlusion from stone, and only in 10 per cent. of the cases of occlusion due to other causes. In all these latter cases he found a well-defined microbic cause for the fever. He, therefore, accepts Schüppel's opinion in this regard. Acorimbini believes that the fever is caused by bacteria which enter the bile-passages from the duodenum or from the circulation. He states that the bacterium coli communis is normally found in the bile-passages, and is a factor in the formation of gall-stones. The bacteria cause a desquamative angiocholitis (Dujardin-Beaumetz, Mosler, Naunyn), and the stone contains the colon-bacillus throughout its mass. When the stone has formed it causes abrasion of the epithelium of the ducts, and the microbes enter and cause inflammation of the wall, which leads to the plastic peritonitis which causes the formation of adhesions between the peritoneal surfaces of the ducts and the surrounding organs.

It seems to me, however, that we cannot positively deny the possibility of a rise in temperature due to the absorption of aseptic bile caused by sudden retention from obstruction due to stone. The fever, according to R. Schmitz, sometimes precedes the colic, and is consequently the earliest symptom of occlusion. If bacterial infection and inflammation of the wall of the ducts cause the fever, why should it cease with the removal of the obstruction? If infection of the bile contained in the biliary passages, the bile being the culture-medium for the bacteria contained in the stone, and if the ptomaïnes thereby produced cause the fever by their absorption, why should the fever in some cases be the earliest symptom, even preceding the pain caused by the obstruction? Furthermore, would we not expect to find in all cases of stone causing remittent attacks of fever that the bile contained some of the microbes, even the most innocent, the colon-bacillus? In my Case IV. the bile from the common duct was sterile, and yet the attacks of retention were always accompanied by marked fever.

OPERATION. Many operations have been employed for the removal of stone in the common duct.

Indirect lithotripsy, crushing, leaves débris, some of which may remain in a pouch in the duct, increase in size, and, as the stone is always a bacterial depot, may cause inflammation of the wall or even cholangitis.

Cholecystenterostomy, the formation of an anastomosis between the gall-bladder and the jejunum, is only possible when the cystic duct is patent.

Choledochoduodenostomy is more generally applicable, but it does not remove the stone, and consequently does not remove the cause of septic inflammation, even if it removes the retention of bile and icterus. A patient of Körte's died from cholangitis caused by a choledochus-stone, notwithstanding the existence of a duodenal fistula which permitted free egress to the bile.

Cholecystenterostomy is an operation of necessity when the obstruction cannot be found or removed. It is never an operation of choice, and will very rarely be called for in cases of choledochus-stone.

Cholecystotomy. It is only in rare cases that a choledochus-stone can be removed through the gall-bladder; namely, when the cystic duct is so dilated as to permit the passage of the stones back into the gall-bladder or of a forceps down to grasp or crush the stones. It is impossible, however, to be sure of removing all of the multiple floating stones through the gall-bladder, as the exploration of the common duct through its lumen can be accomplished only very imperfectly by a sound or probe hrough the gall-bladder.

Perfect, thorough exploration of the common duct should be made by the finger, and should extend up into the hepatic duct, and this can be accomplished only by choledochotomy and exploration through the opening thus made.

The only remaining operation of choice, which has a legitimate field, but is rarely called for, is the trans-duodenal incision over a stone in the dilated diverticulum of Vater. One case of this kind is reported by Pozzi and one by McBurney.

Internal choledochotomy, division of strictures in the common duct through an opening in the gall-bladder, a successful case of which Abbé has reported, is rarely applicable and is a dangerous procedure, as it is an operation in the dark, and there is grave danger of wounding the vena porta or the hepatic artery. My preference in such cases would be to make an external choledochotomy and then deal with the stricture.

Choledochotomy, the choledocholithotomy of Courvoisier, the excision of the gall-stone from the ductus choledochus, is the operation of choice, which is most commonly indicated, and which effects the most complete cure. This operation was proposed by Langenbuch in 1884. Charles T. Parkes, of Chicago, also spoke of the operation in 1885, and proposed to leave the duct open and drain it by means of a rubber drainage-tube, or to close the opening in the duct by sutures. Kümmel, in 1890, stated that several years before, about the time Langenbuch proposed the operation of cholecystectomy, he had a patient, a woman of forty years, in whom, after having extirpated the gall-bladder, he found a choledochus-stone the size of a walnut in the dilated common duct. He incised the duct, removed the stone, and closed the opening with sutures. The operation was long and severe, and the patient died twenty hours after. (Courvoisier.)

Courvoisier was the first to perform choledocholithotomy. He had made the diagnosis of choledochus-stone, and had planned the operation beforehand. He made the first operation on January 22, 1890; operated on a second patient February 18, 1890, and on a third on March 17, 1890, and all three of these operations were successful.

The remarkable success achieved by Courvoisier immediately secured for choledocholithotomy a place in the front rank of the operations for choledochus-stone.

In 1892 Martig had already collected 27 cases, and in 1895 Mermann collected 17 additional, making a total of 44 cases of choledochotomy, with a mortality of 18 per cent.

Technique of choledocholithotomy. The operation is not always easy and requires at the least one to two hours for its performance. The wound is necessarily deep, and the operating on the duct has to be done at the bottom of the wound. The liver is often swollen and hard, and adhesions are almost always present. Good light is absolutely essential. (Mermann.) I prefer daylight to artificial light. Skilled assistants are necessary, as the liver must be lifted and held up, preferably, by the fingers of an assistant. I prefer this to the method proposed by Studsgaard, who had the liver held up by means of a loop of silk passed through the liver-tissue near the border of the organ. (See Plate III.)

A. *Incision.* An incision of ample length is required in order to secure operating-space, and it is often necessary to supplement the longitudinal lateral incision with a transverse horizontal one. (Czerny.) The peritoneum should then be sutured to the skin.

B. *Adhesions.* After the introduction of large flat sponges, the adhesions between the gall-bladder, stomach, transverse colon, and the greater omentum, which are common, should be separated. These organs, together with the duodenum, are often adherent to the common duct. These adhesions are often band-like and comparatively easy to loosen, either by blunt dissection or by division between ligatures, but they necessarily prolong the operation. In some cases, fortunately rather rare, the duct is found buried in such extensive and firm masses of cicatricial tissue that it is impossible to isolate it or even to find the stone. Thus Körte reports two cases of attempted choledochotomy in which he was unable to isolate the common duct, and could not find the stone. At the autopsy on the first case he found, but not until he had removed the liver from the body and laid it upon the table, a small stone in a parietal dilatation of the common duct. In the second case he tried at the autopsy, first, to find the stone through the wound of operation, but in vain, and it was not until the liver and surrounding organs had been removed and laid upon the table for dissection that he was able to find a stone the size of a bean in the common duct, which was firmly adherent to the surrounding organs.

C. *Examination of the gall-bladder.* After isolation of the gall-bladder from the adherent organs it is usually found to be small, atrophic, and empty; it may even be obliterated, but no reports of this condition are on record. Prof. Frank Billings has, however, told me of two cases when he was present at the operation, in which this condition was found. In rare cases it is found to be dilated. A distended gall-bladder should be emptied by aspiration. When stones are found in the gall-bladder and in the common duct the stones in the former must be removed by cholecystotomy. I think it sufficient to open the gall-bladder only when a stone can be felt through its wall. Czerny (Mermann) considers it necessary to incise the gall-bladder and examine it for stones whether stones can be felt through its wall or not.

D. *Isolation of the common duct.* After loosening the adhesions to the gall-bladder the cystic duct is exposed, and the attempt should now be made to lay bare the anterior surface of the hepatico-duodenal ligament. I have ordinarily found in this locality one or more enlarged lymph-glands. The ligament should now be laid bare downward and to the left until the right border of the duodenum is reached. The free right border of the hepatico-duodenal ligament should now be isolated, and the foramen of Winslow found. The index-finger of the left hand should now be passed upward and to the left in the foramen, whereupon the contents of the ligament, namely, the vena porta, the common duct, and the hepatic artery, may be palpated between the index-finger and thumb.

E. *Palpation of the stone* is made by searching the duct from behind the duodenum, at about its middle, upward and to the right as far as the hilus of the liver. A floating stone, if present, is felt at the duodenal end or elsewhere in the duct, and often slips away when the attempt is made to engage it between the finger and thumb. It is easy to find the stone again anywhere in the common duct, but when it slips up into the hepatic duct it disappears, and may require considerable manipulation to bring it down into the common duct again. Czerny in Case XX. (reported by Mermann) performed choledochotomy without finding a stone, but removed two stones from the gall-bladder by ideal cholecystotomy. In Case XLI. biliary colic existed for one week five months prior to the operation. The icterus gradually decreased. The patient was emaciated, had lost thirty-six pounds in weight, and was sleepless. On three occasions small gall-stones were found in the feces. The patient was pronouncedly icteric, and the feces acholic. A median incision was made, and the gall-bladder found to be atrophied. During the loosening of adhesions to the greatly dilated hepatic and common ducts a sudden flow of bile occurred, and, as Mermann states, "consequently a tear or an opening in the common duct." The operator felt through the walls a stone, which was easily displaced, and slipped or floated up under the liver. No stone could be found after exploration with the sharp spoon and the forceps, but only old, blackish-green coagula were brought out. (This, I think, was the crushed stone, as in my Case VI. I encountered a small, third stone, which I could feel with the tip of my finger in the wound, but could not dislodge into the wound by manipulation of the hepatico-duodenal ligament.) The operator searched for the choledochus-stone for an hour, but could not find it. The ductus choledochus was sutured and tamponed; on the second day the drain was removed. The operation lasted two hours; the patient was out of bed in three weeks, and in nine months after the operation had gained forty pounds in weight. Mermann remarks: "Where did the stone that disappeared under the palpating finger, and could not be found, although searched for for an hour, go to? It is not clear; it was not found in the feces. It has probably not remained, as the patient recovered, and was well nine months after the operation. The stone was the size of a pea, and could hardly have passed into the gall-bladder, as the calibre of the cystic duct was not sufficient to permit this." My own idea is that the stone was either crushed during palpation between the thumb and finger, or by the sharp spoon, and that the blackish-green coagula were simply the débris of the crushed stone.

The field of operation should now be surrounded by three, four, or five large flat sponges.

F. *Fixation of the stone* at the place of intended incision is made by grasping the stone between the finger and thumb, and holding or pushing it up against the anterior surface of the duct. When the stone is floating, and we are consequently able to select the point of incision into the duct, it should be moved to the anterior surface of the left or lower half of the duct close to the duodenum. When the stone is yellow we can sometimes see it shining through the thin wall of the duct. In order tc ascertain whether a stone or a tumor of the duct is present, a needle should be passed in, which will grate upon the stone.

G. *The incision in the duct* should be 1½ to 3 centimetres long, and in the direction of the axis of the duct, over the surface of the stone, which should present in the opening and should then be lifted out. The removal of the stone is ordinarily followed by a flow of bile, from which cultures should always be made. The place of incision in case of floating stone can be chosen, and should be, as I have already pointed out in the anatomy, in the duodenal portion of the duct, to avoid wounding the vena porta.

H. *Exploration of the duct* through the wound in it may be made with the finger; in the majority of cases the duct is sufficiently dilated to admit the little finger. It is my custom to explore in both directions: down behind the duodenum and up into the hepatic duct. By this means a small stone not felt upon external palpation of the hepatico-duodenal ligament may be discovered and extracted.

I. *Extraction of stones.* Stones of the common duct can usually be pushed up into the opening by manipulation and will then slide out, or they may be removed by forceps, or lifted out by sliding a sharp spoon behind them, or may be crushed and the débris removed by the sharp spoon. I have had made for this purpose a sharp spoon with a long, flexible handle, which may be bent in any position for the removal of the stone from the duct.

J. *Sounding* the common and hepatic ducts for stone should be accomplished with a metal probe, which upon touching the stone imparts a grating sensation. For this purpose I employ a silver uterine probe. A stone may also be dislodged by this means from the hepatic duct, as in my Case IV.

K. *Probing* to ascertain if the opening or passage down into the duodenum is free cannot always be accomplished, not because of an obstructing stone or stricture, but because the sound may meet a fold of mucosa in the dilated common duct. As bile passes after the removal of the stone, as we know from the remittence of the obstruction symptoms, any further attempt at opening the passage into the duodenum by means of the probe is unnecessary.

L. *Closure* of the wound in the common duct should be accomplished by a double row of sutures: an inner row through the muscular and external coats of the wall of the duct, but not penetrating the mucosa; and an outer row, including or taking in the peritoneum of the anterior wall of the hepatico-duodenal ligament. I usually leave the sutures long, in order to hold up the wound in the duct during the insertion of the following sutures. The insertion of sutures is easy when the wall of the duct is thickened, but difficult when the wall is thin, as the needle penetrates the mucosa and bile flows through the needle-punctures. The outer row of sutures may stop the flow of bile, but it is sometimes impossible to seal the wound hermetically, however carefully the sutures may be applied. In two of my cases no bile exuded from the wound, but in others, which terminated as favorably, there was a discharge of bile for a limited time—a much shorter time than obtained in the majority of my cases of ordinary cholecystotomy.

M. *Drainage* is accomplished by a rubber drainage-tube passed down to the wound in the duct, and gauze-drains inserted one above and the other below the rubber drainage-tube. When the gall-bladder is opened, and instead of being closed is united to the abdominal wall, I drain the gall-bladder by a rubber drain only, and unite the abdominal wall below so as to separate the drains in the gall-bladder and common duct.

CONCLUSIONS. 1. In the great majority of cases of stone in the common duct the duct is dilated, and the stone floats in it.

2. Choledochotomy is the operation of choice, and should be employed whenever applicable, as it is far superior to all other methods of operation.

3. Choledochotomy is applicable in the vast majority of cases of stone in the common duct; the cases demanding other operative procedures are rare.

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